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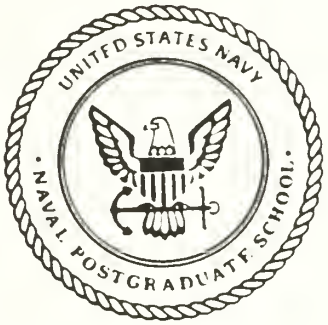


# THESIS

PLAIN ENGLISH TECHNIQUES FOR WRITING MANUALS AND A PROPOSED DSS FOR BASIC INSTRUCTION MANUAL WRITING PROCEDURES

by

Theresa J. Childs

MARCH 1991

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This thesis proposes a design for a DSS that will be used by the designers of instruction manuals for enlisted service members in the grades of E-1 - E-5 in the Department of Defense (DoD). The purpose of this proposed DSS is to help authors create manuals that will be easily comprehended by service members so they can quickly and effortlessly accomplish a task. Current research from the document design field and Plain English movement are reviewed to determine the best way to structure a written document whose sole purpose is adult instruction. The rules for creating the DSS are developed from this literature review.

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# Plain English Techniques for Writing Manuals and a Proposed DSS for Basic Instruction Manual Writing Procedures

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**ABSTRACT**

This thesis proposes a design for a DSS that will be used by the designers of instruction manuals for enlisted service members in the grades of E-1 - E-5 in the Department of Defense (DoD). The purpose of this proposed DSS is to help authors create manuals that will be easily comprehended by service members so they can quickly and effortlessly accomplish a task. Current research from the document design field and Plain English movement are reviewed to determine the best way to structure a written document whose sole purpose is adult instruction. The rules for creating the DSS are developed from this literature review.

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# I. INTRODUCTION

## A. BACKGROUND

The two basic tenets of military leadership are accomplishing the mission and looking out for the welfare of the troops. The mission cannot be accomplished if the troops do not understand how to complete the tasks required to reach the objective. Since personalized individual training cannot be provided to each Airmen, Sailor, Soldier, and Marine, training manuals have been developed for completing certain tasks. However, these manuals are of no value if service members cannot access the information they need quickly and easily.

This thesis examines current material from the document design field and Plain English movement to determine the best way to structure an instruction manual, so it will be useable and understandable. A proposed DSS to help designers reach this goal, will be presented.

## B. OBJECTIVES

The purpose of this thesis is to purpose a DSS that will be used by the designers of instructional manuals for enlisted service members in the grades of E-1 to E-5 in The Department of Defense (DoD). The aim of this DSS is to help authors create manuals that will be easily comprehended by service

members so they can quickly and effortlessly accomplish a task.

## C. THE RESEARCH QUESTION

The primary research question for this thesis is to determine what factors increase the readability and comprehensibility of instruction manuals for adults. The factors to be studied are organization, style, visual structure of the page, and information access. The secondary research question is to determine the best way to structure the DSS.

## D. SCOPE, LIMITATIONS AND ASSUMPTIONS

**Scope:** This thesis focuses on established literature by researchers in the document design and Plain English movements. It does not examine experimental theories or methodologies in either field.

**Limitations:** Specifically the areas to be addressed in the DSS are style, organization, information access, and visual structure of the page and grade level.

**Assumptions:** It is assumed that the officers and managers in the DoD would welcome the chance to improve the instruction manuals currently used by their E-1's - E-5's. Furthermore, style checkers such as "Grammatik IV" and "WriteRighter" primarily check text for grammatical rules only and not for a range of style features, content, information access or visual

structure of the page. Therefore, these checkers would have limited success in testing the readability and/or comprehensibility of instruction manuals.

## E. LITERATURE REVIEW AND METHODOLOGY

Current material from the document design field and Plain English movement will be reviewed to determine the best way to structure a written document whose sole purpose is adult instruction.

## F. ORGANIZATION OF STUDY

Chapter I: Introduction

Chapter II: Literature Review

Chapter III: Rule Selection and Justification

Chapter IV: Proposed DSS Design

Chapter V: Conclusions and Recommendations

## II. LITERATURE REVIEW

This chapter examines current literature in the document design and Plain English field to determine which current practices can be developed into rules for the DSS.

### A. OUTLINE

The information in this chapter will be presented in the following manner:

1. Two factors critical to the useability of a document will be examined. These factors are readability formulas and comprehensibility.
2. The limitations in their applications will be examined.
3. Critical areas that these formulas do not address will be examined for their impact on the adult reader.
4. Specific strategies will be discussed that make documents more readable and comprehensible.

### B. READABILITY FORMULAS

There are two different areas that must be investigated when one studies the useability of instruction manuals: readability and comprehensibility.

Guillemette (1987) defines readability of a text as the extent that the intended readers are able to read it quickly, accept it (i.e. persevere in reading it), and understand it clearly [Ref. 1:p. 41]. Readability can be measured by mathematical formulas that are applied to text to provide an

index of how difficult the text will be for a given group of readers. These formulas measure one or two features of a text to produce a numerical value between 0 and 100 or a grade level. The features most commonly measured are sentence length and word length or word frequency.

Hundreds of formulas have been developed to predict readability for different groups and ages. However, Klare found that no "best" formula exists. Of the widely used formulas, the Dale-Chall formula is the most accurate and the Flesch Reading Scale (FRS) is the most popular [Ref. 1:p. 43] [Ref. 2]. Another formula that is widely used in business and government to test text for adults is the Gunning Fox Index [Ref. 1:p. 46] [Ref. 3:p. 43]. Since these three formulas are so popular, an explanation of each one will be listed below. The mathematical calculations for these formulas are shown in Appendix A.

1. **Flesch Reading Scale**: The formula is based on sentence length and number of syllables per one hundred words. The FRS renders a number between 0 and 100. The lower the number the more difficult the passage is to read. The results from this formula can be converted to grade levels.

2. **Dale-Chall**: The Dale Chall formula counts sentence length and frequency of whether a words appears on a 3000 word list of acceptable words. It yields a grade level estimate.

3. **Gunning Fox Index**: The Fog Index counts sentence length and percentage of polysyballic words (words of 3 or more syllables). It also yields a grade level estimate.

Readability formulas may be used in two ways. First, they are applied to a text after it is written to ensure the text is written at a preselected grade level. If the grade level of the text is higher or lower then the desired grade level, the text is revised accordingly. Second, the formulas can be applied in the same manner to each paragraph as it is written to provide immediate feedback to the writer. Computer editors can be programmed to offer immediate feedback on the readability of individual paragraphs or text. "Grammatik IV" and "RightWriter" are examples of these types of program. Text is first reviewed by an editor. Suggestions for better format and grammar are then generated. In addition, the grade level of the text is determined.

The question that should be asked here is whether or not people should write to formulas. According to Klare (1979), experts in the area of readability agree that it is ineffective to write to formulas, that is, to change only those features measured by the formulas without regard to whether or not the changes made make the materials easier to understand. He feels the best way to design a text that reads at a specified reading level is to use clear writing techniques [Ref. 4:p. 125] [Ref. 5]. Klare has developed a seven step procedure for using readability formulas when designing a document [Ref. 4:p. 125].

1. Apply a formula to see if a piece of writing is likely to be readable to intended readers.

2. If the readability index suggests it is, and if other requirements for good writing have been met, stop here. In other words, that a poor index value predicts poor writing, a good index value by itself need not mean good meaning.

3. If the readability index suggests the piece of writing is not likely to be readable to its intended writers, put the formula aside so as not to be tempted to "write to formula"

4. Rewrite the material, trying to discover and change those parts likely to cause trouble. Use the formula information only as a guide to where to begin.

5. Apply the formula again to see if the piece of writing is now more likely to be readable to intended readers.

6. If it is, and other requirements for good writing are met, stop there.

7. If it is not, repeat steps, 3, 4, and 5 until an appropriate readability index is achieved.

## C. COMPREHENSIBILITY

Comprehensibility is defined as the reader's ability to perform a task after reading text describing how that task should be done [Ref. 4:p. 117]. Since testing a subject's ability to perform a task after reading a text is prohibitive, comprehension tests have been developed. There are several ways to measure comprehensibility. Two common methods are using a Cloze test, or a Cloze test and a reading test. A cloze test requires the subjects to replace deleted words in text (usually in an nth word deletion); a passage with a higher mean number of correct responses is considered more readable. [Ref. 1:pp. 41-42]

Several researchers have assigned comprehension scores to various passages based on combined reader's performance on a reading and a cloze test. For example, Kincaid et al assigned comprehension scores based on the results of the cloze test and the Gates-MacGinite reading test. They said individuals comprehended a passage when they scored 35% or more on a cloze test of that passage. To determine the reading grade level required for comprehending that same passage, they categorized the readers into reading grade levels based on the Gates-MacGinite reading test. Then, all the readers who fell in the same groups were tested to see if 50% or more of the readers in that group comprehended the passage: that is, scored 35% on more on the cloze test.

Caylor *et al.*, used an almost identical procedure to determine comprehensibility of a text. Instead of using the Gates-MacGinite reading test, they used the Kincaid-Flesch formula. According to their test, a reader was said to comprehend a passage when 50% or better of the readers in a specific grade level scored 35% or better on a cloze test for that passage [Ref. 4:p. 122] [Ref. 6] [Ref.7] [Ref. 8]. Since comprehension test are easy to administer and grade and individually testing the users of a text is costly , comprehension test scores are commonly used as the sole measure of comprehensibility.

Even though readability formulas are widely used because of their ease of application, there is widespread disagreement

about their value and effectiveness to predict readability and comprehension. Redish, Selzer, Klare, Guillemette are a few of many researchers who disagree with the ability of reading formulas to predict reading levels. Redish and Selzer have pointed out five problems with readability formulas. [Ref. 3:p. 47]

1. Readability formulas have been applied to technical and business writing with no research basis.

2. Studies show that readability formulas are not reliable and valid predictors of how understandable a technical, scientific or legal document will be for adults.

3. Shortening sentences and words does not necessarily make the sentences and words easier to understand.

4. The underlying assumption of readability formulas - that any text for any reader for any purpose can be measured with the same equation-does not mesh with our current understanding of how people process information.

5. Readability formulas do not take into account many features that are critical to people's ability to understand and use documents: i.e. content, organization and layout.

Klare and Guillemette in discussing the limitations of readability formulas state that they do not measure the effects of the differing purposes, abilities, intelligence, background, expectation ,maturity or motivation in reading. Nor do they measure the effects of format, typography, content or difficulty of the text on comprehension [Ref. 1:p. 45] [Ref. 4:p. 121] [Ref. 2]. Schumachler and Waller state that readability formulas are too global a level of information;

they provide little help in determining either how to produce a well-designed document or how to improve the design of the already existing document [Ref. 9:p. 383]. Guillemette states that an early comprehensive investigation into adult reading led to the identification of four major categories of factors considered useful in predicting the difficulty of reading materials: format, organization, style and content [Ref. 1:p. 45] [Ref. 10]. Readability formulas, however, do not provide an accurate assessment of these factors because they test at most two or three stylistic variables.

Similar doubts about the applicability and useability of comprehension tests also exists. Duffy and Guillemette are a a few of many researchers who disagree with the ability of comprehension tests to predict comprehension. Duffy contends that comprehension test as they are presently designed in principle do not test the "reading comprehension skills required to use a text on the job or in training." Duffy also contends it is impossible to predict the exact comprehensibility of the task; "that is, the task used in the development of the test, is grossly different from the practical tasks for which texts and documents are used [Ref. 4:p. 118]." According to Guillemette, one of the major problem in using comprehension tests "is deciding upon the nature and domain of the questions themselves (*i.e.*, recall vs. inference) [Ref. 1:p. 41]." It is a common practice to use objective type questions (multiple choice) in many

comprehension test. Guillemette states that the use of objective questions have been criticized "because of the possible biasing effects of subject questioning and question formulation." [Ref. 1:p. 41]

## D. CONTENT, ORGANIZATION, FORMAT AND STYLE

In this next section the four factors listed above will be defined. The impact they have on the readability and comprehensibility of a document will be addressed.

1. **Content:** Redish and Selzer define content as the appropriateness and accuracy of the text. In other words, text needs to be designed for its intended purpose. This thesis focuses on procedural documents, which show an individual how to accomplish a task. [Ref. 3:p. 50]

   Guillemette defines content as the theme, nature of subject matter, and unity of content. Content factors affect the interest and compellingness of the material for the reader. [Ref. 1:p. 42]

2. **Organization:** Redish and Selzer define organization as the ease of access to the right information [Ref. 3:p. 50]. It is the use of access devices (i.e. indexes) and reference devices (glossaries) outside of the text of a document, and the use of titles, headings, purpose statements, topic sentences and internal previews within a text. Organizational factors impact accessibility of the reading material for the reader. [Ref. 1:p. 42]

3. **Format/Layout:** Selzer and Redish define format as page layout and typography and the use of graphics [Ref. 3:p. 50].

   Guillemette defines format as the size and binding of the material; page layout appearance and quality; and kind of type and graphical displays. Format factors affect the fluency aspect of the reading process. He states that fluency can be influenced by a number of factors, such as legibility of the basic characters,

variations in character form and size,and the special arrangement of characters on the page. [Ref. 1:pp. 41-42] [Ref. 11] [Ref. 12:pp. 307-340]

4. **Style**: Guillemette defines style as semantic and syntactic variables,tone of the writer, and the method and style of presentation. Linguistic structure or style affects reading behavior. [Ref. 1:p. 42]

Specific strategies will now be discussed to design better manuals. These strategies consider the factors that affect the difficulty of reading material. These strategies will be divided into four specific areas: graphics, organization and access of information, visual structure of the page, and style.

## E. GRAPHICS STRATEGIES

**Graphics** - The author of this thesis defines graphics as the layout, design and placement of graphs, charts, figures and illustrations in the text.

1. **Whenever possible do not present information in prose.** Research has shown that people extract information more quickly and easily when it is presented in lists and tables than when it is presented in prose. [Ref. 13:p. 112] [Ref. 14:pp. 160-61] [Ref. 1 ,

2. **Orient charts so that they are read left to right.** Charts seem to be better processed if they are read left to right. This orientation takes advantage of "normal" reading habits and improves reading speed. It also suggest that charts should be typeset in the same direction as the text whenever possible. [Ref. 16:p. 81] [Ref. 17]

3. **Use a simple line graph if possible.** Simple line graphs should be used to present a few points. One study that treats graphs as a independent element finds that a simple line graph works better than bar graphs or pie

charts when the number of points on the graph are few. [Ref. 16:p. 81]

4. **Use colors wisely and correctly in a graph**. When using colors to illustrate a graph, use only a few colors, also, include a legend and use colors in a manner consistent with general population stereotypes. Color seems to work as a discriminating agent when it includes only a few colors and a careful description of the rationale for the color code. [Ref. 16:p. 81] [Ref. 18:p. 16] [Ref. 19]

5. **Repeat tables whenever they will be used in the text**. Readers find it more advantageous to have tables repeated strategically throughout a text rather than having to perform elaborate searches through lists of tables and indexes to find an often used table. [Ref. 14:pp. 160-161] [Ref. 16:p. 81] [Ref. 20:pp. 331-343] [Ref. 21:pp. 175-187]

6. **Place columns within a table closer together rather than spacing them across a page**. This makes searching easier and reduces additive operations. [Ref. 14:pp. 160-61] [Ref. 16:p. 81] [Ref. 20:pp. 331-343] [Ref. 21:pp. 175-187]

7. **Use the best type of graphical display for a specific purpose**. Studies indicate that tables are superior to graphs when looking up and recalling specific values. They are also superior to graphs when comprehending demographic statistics. Conversely, graphics are superior to tables for subjects asked to compare data. On the other hand, Powers et al finds the combination of text and graphics is superior when subjects required to make decisions when accuracy is required. [Ref. 17:p. 17] [Ref. 22:pp. 361-376] [Ref. 23:pp. 787-789] [Ref. 24:pp. 145-58] [Ref. 25:pp. 32-39] [Ref. 26:pp. 545-566]

8. **Limit the number of visual variables, i.e. size, value,direction, texture, shape, and color when using a visual aid**. Too many visual cues impede comprehension. [Ref. 17:p. 11] [Ref. 27:pp. 595-603]

9. **Be consistent in your organization of graphics from section to section and chapter to chapter so that the same graphics cues mean the same thing**. [Ref. 17:p. 12] [Ref. 28:p. 27]

10. **Use only those lines, grid patterns, necessary to make the information clear.** [Ref. 17:pp. 11-12] [Ref. 27:pp. 595-603] [Ref. 29:p. 38]

11. **Present "one idea per visual"** [Ref. 14:p. 14]

## F. ORGANIZATION STRATEGIES

**Organization** - organization and information access is defined as arranging the content in a logical manner so information is quickly and easily ascertained.

1. **Organize the document according to the reader's stated purpose for the text.** Distinguish between text used for doing and text used for learning. In text used for learning, the reader's goals is to absorb the material and remember it for future use. In text used for doing, the reader's goal is to read enough to act immediately to make a decision or to follow steps in a procedure. A procedural text should be designed differently from a definitional or recreational text. [Ref. 10:p. 104]

2. **Make the document user-oriented not content-oriented.** Put yourself in the user's place and ask questions the reader is likely to ask. Then order the questions and responses logically. [Ref. 10:p. 104] [Ref. 28:p. 20] [Ref. 30:p. 123] [Ref. 31] [Ref. 32]

3. **Include only the information the user needs.** One key to good business writing is to provide only the information that busy people need to accomplish their task. [Ref. 13:pp. 104, 110] [Ref. 28:p. 21] [Ref. 33]

4. **Write headings as questions or verb phrases.** Research supports that nouns by themselves do not help people understand how text is organized. Questions and verb phrase both work well for informative headings. Questions work well for information sheets and brochures. Verb phrases work well for procedural manuals. [Ref. 13:p. 107]

5. **Include a table of contents and an index whenever possible.** This may be the difference between a useful manual and one that sits on the shelf. Index verbs as well as nouns and include in the index words that the

readers will bring to the document even if those words are not in the document [Ref. 13:p. 109]

6. **Set up signposts.** At the beginning of a document, set the overall context by telling the reader what is in it, why they might choose to read parts of it, and what you expect them to get from it. When you get down to the procedure and details, set the context repeatedly. Don't just tell them why and under what circumstances they might choose to do that procedure, rather than another procedure. [Ref. 28:p. 22]

## G. VISUAL STRUCTURE OF A PAGE STRATEGY

**Visual structure of a page** - Visual structure of a page is defined as the arrangement and layout of type, words, sentences and paragraphs in a text to enhance the appearance of the text on the page.

1. **Use boldface type to emphasize words or short portions of text.** Research suggests that when a text has a logical structure, typographic distinction such as changes in types, weight, or typeface may help readers understand the structure. Research specifically indicates that readers notice changes in type weight (heavy, medium, light) more readily than they notice changes in typeface and that readers find very light or very heavy type tiring and difficult to read. [Ref. 16:p. 79] [Ref. 29:p. 37] [Ref. 34] [Ref. 35:pp. 57-66] [Ref. 36] [Ref. 37] [Ref. 32:p. 79] [Ref. 33] [Ref. 34]

2. **Use italics and capitalization when one needs to slow down reading rates.** Research has shown that italics and capitalization will consistently slow down reading rates. Their usefulness is in cautions, warnings and the like. [Ref. 16:p. 80] [Ref. 38] [Ref. 39] [Ref. 40:pp. 273-280] [Ref. 41:pp. 542-570] [Ref. 42:pp. 137-146] [Ref. 43:pp. 541-550]

3. **Use white space to enhance the appearance of the text.** Text can be enriched by selectively using certain elements that create additional white spaces around letters, words, and lines. One can add informational value to a text by using selective typography to

achieve specific reader reactions, or they can judiciously apply certain criterion for additional white space such as word and letter spacing, extra leading and paragraph leading. [Ref. 16:p. 81] [Ref. 29:pp. 36, 38] [Ref. 44:pp 90-95] [Ref. 45:pp. 633-640] [Ref. 46:pp. 457-471] [Ref. 47] [Ref. 48:pp. 39-42]

4. **Choose between a serif and sans-serif typeface according to the visual tone of the document you want.** Use a type size of 10 points or larger, two or more points of leading between each line, and a moderate line length. [Ref. 29:p. 36]

5. **Avoid using all uppercase letters.** Research supports the conclusion that text printed in lowercase letters is faster and easier to read than text set in uppercase letters. [Ref. 29:p. 37] [Ref. 49] [Ref. 50] [Ref. 51] [Ref. 52]

## H. STYLE STRATEGIES

**Style** - style is defined as the writer's selection and choice of words, sentence types and structure to make the text more readable and understandable.

1. **Use personnel pronouns**

2. **Use strong action verbs**

3. **Include the user in the text.** Flower et al "found that readers most often converted passive-nominal sentences into active-verbal sentences in order to understand passages. The researchers coined the phrase "scenario principle" to describe text that is "structured around a human agent performing actions in a particularized situation." The principle has proven to be one of the easiest to teach trainees. The principle unites and explains several guidelines commonly suggested by style manuals, namely use personal pronouns, active voice, and use concrete, specific verbs. [Ref. 53:p. 53] [Ref. 54:pp. 21-32] [Ref. 55:pp. 41-58]

4. **Use active and passive voice at the appropriate times.** Active voice works well if the purpose of the document is to stress the consequence of an action. However if

the receiver is more important than the action, a passive construction is often the best choice. [Ref. 53:p. 53] [Ref. 30:p. 117] [Ref. 33:pp 5-15] [Ref. 56]

5. **Use Some contractions.** Research has shown that readers are less likely to see the not when it is not contracted. It also generally accepted that the tone of a document is less formal when contractions are used. [Ref. 57:pp. 1-11]

6. **Use ordinary words.**

7. **Present information in concrete terms.** More recent research has shown that it is not just the length of a sentence that affects how easily readers can understand it. Material presented in concrete terms is easier to understand than material presented in abstract terms. Mclaughlin determined that whereas a less legible, more difficult version of a technical pamphlet did not impede performance for highly motivated individuals, individuals indicated they would never have used it except under duress. Less motivated subjects performed significantly worse with the more difficult version. Simpler reading materials are generally preferred, even when the reader is capable of understanding more difficult versions of the same material. [Ref. 1:p. 41] [Ref 10:p. 112] [Ref. 57:pp. 1-12] [Ref 58:pp. 257-259] [Ref. 59:pp. 1-5]

8. **Avoid Nominalizations**. Flowers, Hayes, and Swarts found that readers had problems understanding writing that was full of passive sentences with noun strings and nominalizations (nouns made out of verbs) [Ref. 3:p. 49] [Ref. 55:pp. 41-58] [Ref. 57:pp. 1-12]

9. **Write sentences that do not overtax short term memory.** Propositional density (the number and organization of ideas) is more important than the number of words. Even in sentences of reasonable length, grammatical structure can create comprehension problems. For example, sentences with extra phrases at the beginning (left branching) and sentences with the extra phrases in the middle (center embedded) are more difficult to understand than sentences with extra phrases tacked onto the end (right branching) [Ref. 53:p. 54] [Ref. 13:p. 112] [Ref. 60:pp. 491-499] [Ref. 61] [Ref. 62:pp. 5-8] [Ref. 63:pp. 17-22] [Ref. 64:pp. 292-303] [Ref. 65:pp. 512-521] [Ref. 66:pp. 289-296]

10. **Avoid the use of complex conditional sentences.** Sentences of this type are difficult for readers to

understand. Holland and Rose (1981) found out that, after a brief initial practice session, people could assign themselves the proper condition more quickly and more accurately from an algorithm (a paper flowchart) than from single prose sentence [Ref. 53:pp. 54-55] [Ref. 15]

11. **Line Length**. There is a number of opinions on the correct line length. According to Tinker (1965), a line length of 50 to 70 characters is easiest for the eye to scan [Ref. 53:p. 55] [Ref. 38]. According to Frase, McDonald and Keenan The mean best line lengths for passages in different readability groups were also different: 44, 50, and 56 characters for the easy, medium and difficult groups respectively. Their data suggested that line length between 40 and 60 are suitable for most texts. [Ref. 67:p. 104]

The design of a document includes incorporating the guidelines presented in each of the four areas to create a easily used document. Following the principles outlined above will allow a document designer to produce a useable product.

In the next chapter the characteristics of the target audience, Department of Defense (DoD) E-1's - E-5's, will be determined. The guidelines presented in this chapter will then be reviewed to determine which ones will be used to create the rules for the decision support system (DSS).

## III. RULE SELECTION AND JUSTIFICATION

In this chapter the guidelines discussed in Chapter II will be reviewed to determine which one will be used as the DSS's rules. The information in this chapter will be presented in the following manner:

### A. OUTLINE

1. A profile of the target audience who will use the manuals developed from this DSS will be established.

2. Information about the instruction manuals currently in use will be provided.

3. Poor instruction manual characteristics that have caused user difficulties will be discussed. Justification for the rules chosen for the DSS will also be presented in this section.

4. Problems caused as a result of poorly constructed manuals will be outlined.

### B. TARGET AUDIENCE PROFILE

In this section a composite profile of the reading skill level and educational background of DoD E-1's to E-5's is established. To achieve this composite, the Defense Department Management Center (DMDC) provided a listing of Armed Forces Vocational Aptitude Battery (ASVAB) Verbal (VE) composite scores for enlisted pay grades E-1 to E-5 for each of the different services and for DoD as a whole. The ASVAB VE score is important because it can be converted into a reading grade

level (RGL). The RGL obtained from the VE scores will be used to get an idea of the reading level of the typical instruction manual user. Water et al state that:

> A common metric of reading ability has been reading grade level (RGL). A RGL scale is developed by administering a reading test to students at every grade level (1st through post-high school). The RGL scale points are then determined in reference to the average score within each grade, as reflected by school year and month (e.g. a RGL of 9.2 refers to the second month [October] of the ninth grade). [Ref. 68:p. i]

The RGL was used as the sole metric to measure reading ability. In October 1988, Brain K. Waters et al coauthored a report entitled " Estimating the Reading Skills of Military Applicants: Development of an ASVAB to RGL Conversion Table. [Ref. 62]

**The objectives of this study were to:**

1. Measure the reading ability of military applicants using six reading tests.
2. Select one ASVAB composite (anchor) with which to equate the reading tests.
3. Equate each reading tests to the anchor.
4. Recommend a RGL scale for DOD reporting purposes. [Ref. 68:p. i.]

In the study conducted by the authors, five ASVAB composites and six reading tests were examined. The five ASVAB composites and six reading tests used in this study are listed below.

| Composite Name | ABBREV. | Subtests in Composite |
|---|---|---|
| Armed Forces Qualification Test-Old | AFQT-O | AR+PC+WK+NO/2 |
| Armed Forces Qualification Test-New | AFQT-N | AR+MK+2 (PC+WK) |
| Verbal | VE | WK+PC |
| General-Technical | GT | AR+WK+PC |
| Verbal(DOD Student Testing Program) | VRB | WK+PC+GS |

| Reading Test | Level | Form | For Grades |
|---|---|---|---|
| The Adult Basic Learning Examination | 3 | E | 9-12 |
| Air Force Reading Abilities Test | -- | A | AF Enlistees |
| Gate MacGinite Reading Test | F | 1 | 10-12 |
| Nelson-Denny Reading Test | -- | E | 9-12 |
| The Test of Adult Basic Education | A | 5 | 8.6-12.9 |
| Stanford Test of Academic Skills | 1 | E | 8-12 |

**AR Arithmetic Reasoning**
30 items that require examinees to solve word problems typically involving simple calculations. Time limit is 36 minutes

**PC Paragraph Comprehension**
Examinees read several short paragraphs and answer 15 questions that assess their understanding of what they have read. Time limit is 13 minutes.

**WK Word Knowledge**
35 items that require examinees to select the correct meaning of the word or to identify a synonym. Time limit is 13 minute.

**NO Numerical Operations**
Examinees are given 3 minutes in which to solve 50 items involving simple calculations. The test is designed to measure calculation speed.

**MK Mathematics Knowledge**
25 items that measure examinees knowledge of high school level mathematics (algebra, geometry, elementary trigonometry) Time limit is 24 minutes.

**GS General Science**
25 items that measure examinees knowledge of the biological and physical sciences. Time limit is 11 minutes. [Ref. 68:pp. 16, 17, 19]

**The methodology of the study was as follows:**

Twenty thousand, four hundred and twenty-two applicants for military service were administered one of the six

published reading tests,along with the Armed Forces Vocational Aptitude Battery (ASVAB). Tests were given at 15 Military Entrance Processing Stations and their associated 214 Mobile Examining Team Sites during a six-week period in spring 1987. Order of the ASVAB or reading test administration was counterbalanced across testing sessions. [Ref. 62:p. i]

**Study Conclusions were:**

1. The median RGL of military applicants is 10.9 using the proposed DOD RGL scale.
2. ASVAB VE (WK+PC) is the best anchor test for equating ASVAB to the reading tests.
3. The distribution of Air Force Reading Abilities Test (AFRAT) total reading scores was closest to the distribution of ASVAB VE of the reading tests in the study. [Ref. 68:p. ii]

The final products of the study are raw conversion tables which provide a single DOD RGL scale for each of five reading tests.

Even though DoD commissioned the study, the RGL scale this study developed has not been officially approved by DoD. The (RGL) scale developed in this study will be used to convert ASVAB VE composite scores into RGLs because it makes use of readily available data on the E-1's to E-5's currently in the DoD. The listing of ASVAB VE scores broken down by rank and service complied by DMDC is in Appendix B. This listing also breaks down the target population (E-1 to E-5) into high school and non-high school graduates.

Table I, Total DoD Members at Different VE Scores is a listing of the total number of enlisted service members E-1 to E-5 in each VE level, by individual service. The purpose of this table is to show the number of enlisted service members at each different RGL. The RGL that these scores corresponds to are also displayed in this table. At the bottom of this table the percentage of high school graduates in each service is displayed. The percentage of high school graduates was obtained by dividing the total number of high school graduates in a category by the total number of service members in that category.

Table II, Average VE Scores for DoD Members lists the data used to find the average VE score and the RGL for each service. The purpose of this table is to show the numerical calculations used to determine the average VE score for each of the different services. The averages were obtained by multiplying the ASVAB VE score by the total number of service members with that score. The sum of these multiplications were divided by the total number of service members in that category.

The data in Tables I and II are significant because they enable us to determine the RGL for E-1's - E-5's in the DoD and use this RGL as the level at which DoD instruction manuals should be written. VE scores for DoD as a whole are presented graphically in Figure 1.

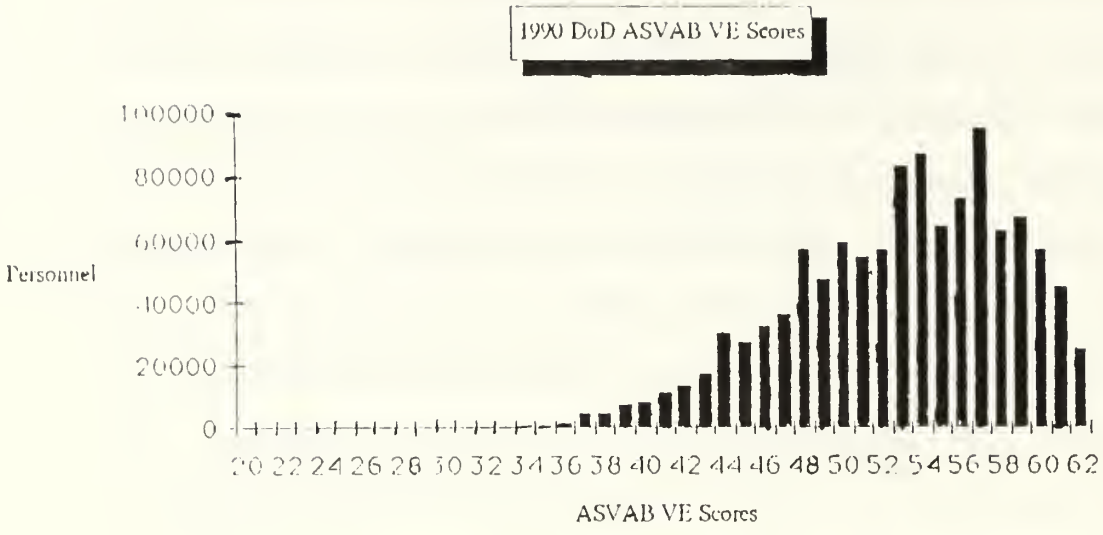


**Figure 1. 1990 DoD ASVAB VE Scores**

In 1980 a vocational aptitude battery, ASVAB, was given to a nationally representative sample of nearly 12,000 young men and woman between the ages of 16 to 23. The sample contained approximately equal proportions of males and females, including individuals from urban and rural areas, and from all major census regions. This analysis, conducted by the Office of the Assistant Secretary of Defense, focused only on young civilians who were 18 to 23 years of age at the time of testing. The results of the testing was published in the 1982 publication "Profile of American Youth." According to the profile, the mean RGL was 9.4, the median RGL was 9.6, and the standard deviation was 2.41. [Ref. 69:p. 82]

The RGL's obtained from this study and the analysis of the data in Tables I and II are presented below. The RGL's for DoD service members and the civilian population are

## TABLE I. TOTAL DoD MEMBERS AT DIFFERENT VE SCORES

| VE | Army | Navy | MC | AF | DoD Total | DoD RGL |
|---|---|---|---|---|---|---|
| 20 | 15 | 8 | 5 | 0 | 28 | <2.8 |
| 21 | 22 | 15 | 4 | 2 | 43 | <2.8 |
| 22 | 1 | 0 | 0 | 0 | 1 | <2.8 |
| 23 | 2 | 3 | 0 | 0 | 5 | <2.8 |
| 24 | 2 | 0 | 0 | 0 | 2 | <2.8 |
| 25 | 0 | 1 | 1 | 0 | 2 | 2.8 |
| 26 | 4 | 4 | 0 | 0 | 8 | 3.1 |
| 27 | 18 | 5 | 0 | 1 | 24 | 3.4 |
| 28 | 19 | 8 | 2 | 3 | 32 | 3.7 |
| 29 | 42 | 18 | 1 | 2 | 63 | 4.0 |
| 30 | 79 | 30 | 6 | 0 | 115 | 4.3 |
| 31 | 115 | 62 | 9 | 5 | 191 | 4.6 |
| 32 | 193 | 79 | 11 | 8 | 291 | 4.9 |
| 33 | 309 | 158 | 16 | 11 | 494 | 5.2 |
| 34 | 543 | 273 | 31 | 19 | 866 | 5.5 |
| 35 | 591 | 362 | 45 | 36 | 1034 | 5.8 |
| 36 | 993 | 548 | 94 | 67 | 1702 | 6.1 |
| 37 | 2461 | 1457 | 273 | 256 | 4447 | 6.4 |
| 38 | 2351 | 1564 | 304 | 231 | 4450 | 6.7 |
| 39 | 3783 | 2787 | 574 | 364 | 7508 | 7.0 |
| 40 | 3938 | 3035 | 736 | 568 | 8277 | 7.3 |
| 41 | 5256 | 3981 | 1010 | 773 | 11020 | 7.6 |
| 42 | 6286 | 4383 | 1314 | 1279 | 13717 | 7.9 |
| 43 | 7562 | 6011 | 1834 | 1780 | 17187 | 8.2 |
| 44 | 13676 | 10680 | 3350 | 2962 | 30668 | 8.5 |
| 45 | 11879 | 9079 | 3318 | 3460 | 27736 | 8.8 |
| 46 | 13569 | 10364 | 4049 | 4819 | 32801 | 9.1 |
| 47 | 14727 | 10892 | 4482 | 5963 | 36064 | 9.4 |
| 48 | 23066 | 16810 | 7485 | 9836 | 57197 | 9.7 |
| 49 | 18369 | 13331 | 6004 | 9457 | 47161 | 10.0 |
| 50 | 23357 | 16448 | 7829 | 12003 | 59637 | 10.3 |
| 51 | 20479 | 14642 | 7138 | 12480 | 54739 | 10.6 |
| 52 | 21100 | 15170 | 7546 | 13631 | 57447 | 10.9 |
| 53 | 30805 | 21733 | 11021 | 19782 | 83341 | 11.2 |
| 54 | 29837 | 22737 | 10743 | 24280 | 87597 | 11.5 |
| 55 | 22890 | 17408 | 8148 | 16310 | 64756 | 11.8 |
| 56 | 25926 | 19823 | 9129 | 18255 | 73133 | 12.1 |
| 57 | 33611 | 26250 | 11641 | 24006 | 95508 | 12.4 |
| 58 | 21855 | 17659 | 7439 | 16380 | 63333 | 12.7 |
| 59 | 23313 | 18892 | 7470 | 17554 | 67229 | >12.9 |
| 60 | 19771 | 16608 | 6089 | 14927 | 57395 | >12.9 |
| 61 | 15706 | 13074 | 4394 | 11768 | 44942 | >12.9 |
| 62 | 8855 | 7570 | 2221 | 6603 | 25249 | >12.9 |
| Total | 427376 | 324417 | 135766 | 249881 | 1137440 | |

TABLE II. AVERAGE VE SCORES FOR DoD MEMBERS

| VE | VE*ARMY | VE*NAVY | VE*MC | VE*AF | VE*DoD |
|---|---|---|---|---|---|
| 20 | 300 | 160 | 100 | 0 | 560 |
| 21 | 462 | 315 | 84 | 42 | 903 |
| 22 | 22 | 0 | 0 | 0 | 22 |
| 23 | 46 | 69 | 0 | 0 | 115 |
| 24 | 48 | 0 | 0 | 0 | 48 |
| 25 | 0 | 25 | 25 | 0 | 50 |
| 26 | 104 | 104 | 0 | 0 | 208 |
| 27 | 486 | 135 | 0 | 27 | 648 |
| 28 | 532 | 224 | 56 | 84 | 896 |
| 29 | 1218 | 522 | 29 | 58 | 1827 |
| 30 | 2370 | 900 | 180 | 0 | 3450 |
| 31 | 3565 | 1922 | 279 | 155 | 5921 |
| 32 | 6176 | 2528 | 352 | 256 | 9312 |
| 33 | 10197 | 5214 | 528 | 363 | 16302 |
| 34 | 18462 | 9282 | 1054 | 646 | 29444 |
| 35 | 20685 | 12670 | 1575 | 1260 | 36190 |
| 36 | 35748 | 193728 | 3384 | 2412 | 61272 |
| 37 | 91057 | 53909 | 10101 | 9472 | 164539 |
| 38 | 89338 | 59432 | 11552 | 8778 | 169100 |
| 39 | 147537 | 108693 | 22386 | 14196 | 292812 |
| 40 | 157520 | 121400 | 29440 | 22720 | 331080 |
| 41 | 215496 | 163221 | 41410 | 31693 | 451820 |
| 42 | 264012 | 203196 | 55188 | 53718 | 576114 |
| 43 | 325166 | 258473 | 78862 | 76540 | 739041 |
| 44 | 601744 | 469920 | 147400 | 130328 | 1349392 |
| 45 | 534555 | 408555 | 149310 | 155700 | 1248120 |
| 46 | 624174 | 476744 | 186254 | 221674 | 1508846 |
| 47 | 692169 | 511924 | 210654 | 280261 | 1695008 |
| 48 | 1107168 | 806880 | 359280 | 472128 | 2745456 |
| 49 | 900081 | 653219 | 294196 | 463393 | 2310889 |
| 50 | 1167850 | 822400 | 391450 | 600150 | 2981850 |
| 51 | 1044429 | 746742 | 364038 | 636480 | 2791689 |
| 52 | 1097200 | 788840 | 392392 | 708812 | 2987244 |
| 53 | 1632665 | 1151849 | 584113 | 1048446 | 4417073 |
| 54 | 1611198 | 1227798 | 580122 | 1311120 | 4730238 |
| 55 | 1258950 | 957440 | 448140 | 897050 | 3561580 |
| 56 | 1451856 | 1110088 | 511224 | 1022280 | 4095448 |
| 57 | 1915827 | 1496250 | 663537 | 1368342 | 5443956 |
| 58 | 1267590 | 1024222 | 431462 | 950040 | 3673314 |
| 59 | 1375467 | 1114628 | 440730 | 1035686 | 3966511 |
| 60 | 1186260 | 996480 | 365340 | 895620 | 3443700 |
| 61 | 958066 | 797514 | 268034 | 717848 | 2741462 |
| 62 | 549010 | 469340 | 137702 | 409386 | 1565438 |
| Total | 22366806 | 17052955 | 7181963 | 13547164 | 60148888 |

| | | | | | |
|---|---|---|---|---|---|
| **YE Avg.** | 52.34 | 52.56 | 52.90 | 54.21 | 52.88 |
| **RGL** | 11.0 | 11.1 | 11.2 | 11.6 | 11.2 |

presented side by side to provide the reader with a basis with which to compare the reading level of DOD service members.

| | **ARMY** | **NAVY** | **MC** | **Air F** | **DoD** | **Youth** |
|---|---|---|---|---|---|---|
| **VE Average** | 52.34 | 52.56 | 52.90 | 54.21 | 52.88 | |
| **RGL** | 11.0 | 11.1 | 11.2 | 11.6 | 11.2 | 9.4 |
| **% HS GRAD** | 92.67 | 92.04 | 93.46 | 99.55 | 94.09 | 59.96 |

The DoD RGL of 11.2 corresponds closely to the 10.9 RGL average obtained by the Brain K. Waters et al study.

To conclude, the average RGL for E-1 to E-5 in the DoD is 11.2, and 94.09% of the members in this group are high school graduates.

The question here is why the readability level of E-1's to E-5's is being presented if there are doubts about the ability of readability formulas to accurately predict the readability of a document. The answer is that readability formulas and comprehensibility scores have value if they are not the sole criteria on which the readability and useability of a text is based. As indicated in Chapter two "experts in the area of readability agree that it is ineffective to write to formulas, that is, to change only those features measured by the formulas without regard to whether or not the changes made make the materials easier to understand [Ref. 4:p. 125] [Ref. 5]." If the reading level of a targeted audience is known (as discussed above) and document designers desire to write to

that reading level, documents should first be checked for the other factors that affect its readability and useability. Then the reading level of the document should be adjusted up or down to reach the desired reading level. These factors as identified in this thesis are graphics, organization and information access, visual structure of a page, and style.

## C. RULE SELECTION AND JUSTIFICATION

In this section, justification for selecting and not selecting individual guidelines will be provided. Justification is based on:

1. The profile of the target audience (discussed above).
2. Characteristics of manuals currently in use.
3. Poor instruction manuals characteristics that have caused user difficulties.
4. The difficulty experienced by the document users as a result of poor instruction manual characteristics.
5. Current practices in the Plain English and document design field.

### 1. Characteristics of Instruction Manuals Currently in Use

1. Their purpose is to provide listings of the steps necessary to complete a task, which the user should be able to learn from quickly.
2. They are normally a collection of instructions detailing how to complete a number of various tasks.

3. Length is variable, and size is proportional to the number of tasks being described. Manuals are generally longer than 25 pages.

4. They are generally narrative in nature.

5. They normally include some type of illustrations pertinent to the tasks being described.

6. The listing of steps and procedures should not be so voluminous as to discourage use.

## 2. Poor Instruction Manual Characteristics That Have Led to User Difficulties

The poor instruction manual characteristics that have caused user difficulties are listed below. The guidelines from Chapter II which correct/address a specific characteristics and serve as justification for the rules used in the DSS, are listed immediately below the characteristics it references.

1. **Official titles and terms or complex words that refer to ordinary tasks that are commonly referred to in colloquial terms.**

    a. Use personal pronouns
    b. Use strong action verbs.
    c. Use ordinary words
    d. Present information in concrete terms.

        1. Research has shown that readers often convert passive-nominal sentences into active-verbal sentences in order to understand passages. Researchers coined the term "scenario principle" to describe text that is "structured around a human agent performing action in a particularized situation." This principle unites and explains several guidelines commonly suggested by style manuals, namely use personal pronouns, write in active voice, and use concrete, specific verbs. [Ref. 4:p. 125] [Ref. 5]

2. If information is presented in the simplest and most direct manner, information can easily be obtained from text.

3. Presenting information in this manner will lessen the chance that needed information will be misunderstood by enlisted service members.

4. If information is easy for your troops to find and use, it will be used.

2. **Too many new ideas or concepts are presented in a sentence.**

   a. Write sentences that do not overtax short term memory.

      1. Research has shown that it is easier to process information presented in concrete terms than in abstract terms.

      2. If sentences are poorly constructed, their meanings may be obscure. This may mean that troops will not be able to extract the information they need to complete a task. Simple direct sentences are the best why to present information.

3. **Too much needless information about a concept or idea is presented in a sentence or paragraph.**

4. **Terms and concepts presented in the manual are not defined before they are used.**

   a. Include only the information the user needs

      1. If superfluous information is presented in a manual, there is a chance that it will be acted upon.

      2. If information is kept simple, there is little chance that it will be misunderstood.

      3. Presenting only the necessary information in a manual saves troops time,as their time is not taken up weeding through useless information.

5. **Directions for completing a task that require the user to evaluate the status of a condition(s) is presented in a sentence or paragraph vice a flowchart.**

a. Avoid the use of complex conditional sentences.

1. Research has shown that complex sentences with a lot of prepositional phrases are difficult to understand.

6. **Directions for completing a task that require the user to perform a series of steps is presented in a sentence or paragraph vice a step-by-step listing.**

a. Whenever possible do not present information in prose.

1. Research has proven that it is quicker and easier for people to read lists than prose.

2. By presenting information in a step-by-step format. The OIC/NCOIC can ensure that all the needed steps in a task are completed in the right order. This ensures that E-5's and below know exactly what actions to perform and in what order to perform them to complete a task.

7. **Directions and the tables and graphs that support those directions are not located in the same place in the manual.**

a. Repeat tables whenever they will be used in the text.

b. Place columns within a table closer together rather than spacing them across a page.

1. Research has proven that people would rather have tables repeated in a text vice having to search for ones previously displayed in the text.

2. Research has proven columns in a table that are closer together make searching for information easier.

3. When information is repeated where it is to be used, it is very easy for enlisted service members to have the correct information when they need it. Requiring troops to go back and search for previously referenced information may make completing a task difficult. It is hard to follow instructions one place in a manual when its complementary data is somewhere else in the manual.

8. **Directions are provided, but there are no illustrations or they poorly support the directions.**

   a. Use the best type of graphical display for a specific purpose.

      1. Research has proven that different types of graphs are better for processing certain types of information.

         a. Tables are superior to graphs for looking up and recalling specific values and comprehending demographics statistics.

         b. Graphs are superior to tables for comparing data Tables and graphs are superior to text when making decisions where accuracy is required.

      2. Using graphs and or tables for the specific tasks it complements, will enable E-5's and below to extract the correct information qicker and easier, thus making it easier for them to complete an assignment.

9. **There is no table of contents**

   a. Include a table of contents and an index
   b. Set up signposts

      1. A document is easier to use if the reader knows the direction the text will take throughout the text.

      2. E-5's and below will be more apt to use a manual if the information is easily found and accessed. If the information is hard to find, it will not be used.

10. **There were no headings for paragraphs that introduced new ideas or for paragraphs that linked together different aspects of the same idea.**

    a. Write headings as question or verb phrases.

       1. Research shows that headings as questions or verb phrases helps the user understand the text.

       2. Making the information easy to find or use will encourage enlisted service members to use

it, since they will not get discouraged looking through excessive information.

11. **Crucial Information about completing a task which the user must know before attempting to perform that task is presented in the same manner and format as noncrucial information. Crucial information is not emphasized, set aside, or highlighted.**

    a. Use boldface type to emphasize words or short portions of the text.

        1. Research shows that highlighting text makes it stand out.

        2. Boldface type can be used to emphasize the information that the OIC/NCOIC feels is very important and needs to stand out.

    b. Use white space to enhance the appearance of text.

        1. Research shows that value can be added to information by selectively using white space.

        2. White space can be added to words, sentences, and paragraphs to make them easier to read or stand out. Therefore, white space can be added to words, etc. to emphasize them or make them stand out.

Poorly designed manuals cause problems that will impact on the users ability to complete the mission. The problems caused as a result of the difficulties users experienced from poorly constructed instruction manuals are listed below.

### 3. Problems Caused as a Result of Difficulties Users Experienced From Using Poorly Constructed Manuals

1. Tasks were completed incorrectly.
2. Tasks simply were not done.
3. Inordinate amounts of time were spent completing tasks.

4. Tasks were completed only after going to other instruction manuals or having a knowledgeable person demonstrate how to complete the task.

The guidelines established in Chapter two that will serve as rules for the DSS have been justified above. The guidelines in Chapter two that were not presented in the previous section were not selected as rules for the DSS; they did not specifically address/correct poor instruction manual characteristics that have caused users difficulties. These guidelines are listed below.

## D. NON SELECTED GUIDELINES

### 1. Graphics (Nonselected Guidelines)

1. Use colors wisely and correctly in a graph
2. Be consistent in your organization of graphics from section to section and chapter to chapter so that the same graphics cues means the same thing.
3. Use a simple line graph if possible
4. Limit the number of visual variables, i.e. size, value, direction, texture, shape, and color when using a visual aid.
5. Use only those lines, grid patterns, necessary to make the information clear.
6. Present one idea per visual

### 2. Organization (NonSelected Guidelines)

1. Organize the document according to the reader's stated purpose for the text.
2. Make the document user-oriented not content-oriented.

### 3. Visual Structure of a Page (Nonselected Guidelines)

1. Choose between a serif and sans-serif type face according to the visual tone of the document of the document you want.
2. Use italics and capitalization when one needs to slow down reading rates.
3. Avoid using all uppercase letters

### 4. Style (Nonselected Guidelines)

1. Include the user in the text
2. Avoid Nominalizations
3. Use active and passive voice at the appropriate times.
4. Use some contractions
5. Line length

The author of this thesis does not feel she should prioritize the difficulties encountered by manual users because she cannot adequately predict what problems different users feel are the most crucial.

In this chapter the guidelines used and not used in the DSS were justified. In the next chapter, the system's design will be discussed.

# IV. PROPOSED DSS DESIGN

In this chapter a proposed design for the DSS is presented.

## A. OUTLINE

The information in this chapter is presented in the following manner:

1. There will be a brief discussion of the cognitive factors that effect user interface. Justification of the system design based on these factors, will also be provided.
2. The hardware constraints of this system will be listed.
3. The DSS's design will be illustrated using computer screens.

## B. COGNITIVE FACTORS THAT AFFECT THE DESIGN OF USER INTERFACE

There are several learning phases an individual goes through when he/she learns a new skill. Fitts and Posner (1967) have termed these phases, cognitive phase, associative phase and autonomous phase [Ref. 70: p. 169] [Ref 71]. They are explained below.

1. **Cognitive Phase:** In this phase the beginner attempts to understand the skill and is able to crudely perform the task using existing habits. Verbal mediation, rehearsal, and extensive feedback are characteristics of this phase.

2. **Associative Phase**: In this phase the user attempts to learn the components of the new skills. He or she tries various actions and gradually eliminates the ones that are inappropriate. Because the skills are being refined, the need for verbal mediation and low-level feedback are reduced.

3. **Autonomous Phase**: The user further refines the skills he/she has learned, until the processes become increasingly automatic, and less subjective to interferences from other tasks. In this phase the user may not need verbalization or feedback.

In the cognitive and associative states of skill acquisition a person learns new skills, and refines or reorganizes existing skills. As part of this progression, "the nature of a person's knowledge appears to change from an explicit verbalizable form to an implicit automatically accessed form [Ref 70:p. 170]." These forms of knowledge have been termed declarative and procedural [Ref. 70:p. 170] [Ref 72] [Ref 73] [Ref 74]. Declarative knowledge is characterized by the fact that one is required to interpret and process new facts that have been articulated to them. Procedural knowledge is characterized by the fact that one accesses direct knowledge of physical phenomenon or mental processes. The processing of declarative knowledge requires much use of working memory because the interpretation and manipulation of knowledge is under control rather than occurring automatically. [Ref. 70:p. 174] [Ref. 75].

## C. SYSTEM DESIGN JUSTIFICATION

Because one is unfamiliar with the material being presented and feedback is constantly needed, this process is slow and laborious. Because the user will only use this system when he/she is developing an instruction manual, it is anticipated that their skills will never become automatic. Therefore the system is designed as if the user is in the cognitive learning phase and manipulating declarative knowledge. Comprehensive instructions are given, extensive feedback is provided, and minimal computer skills are required to use the system. This is evidenced by:

1. The extensive guidance provided in Figures 2 - 4.
2. The simple layout and design of the rule selection screens Figures 5 - 8.
3. The layout and guidance provided in the recommendation screens. Figures 10-14.

## D. SYSTEM HARDWARE CONSTRAINTS

The system is designed to be displayed on a 19" full page monitor. This is a very important requirement because visual structure of a page is one of the variables that the DSS checks pages of proposed manuals against. An individual using the DSS will not be able to adequately evaluate the way information is presented on a page if information is shown on a space 1/2 to 1/3 the size of a page. A page's dimension are defined as 8 1/2" by 11".

## E. PROPOSED SYSTEM DESIGN

The system is designed to provide feedback after the user has completed a proposed page in the manual. After a page has been completed, Figure 2 will appear. It tells the user about general instructions. After Figure 2 is displayed, Figure 3 will be displayed, telling the user how the feedback will be displayed. It explains what types of advice the system provides and allows the user to select the type of advice they prefer [Ref. 76:p.49]. To select the type advice to be given, the user chooses a critic. The critic used in Figures 10-14 is active/positive. After the user chooses an expert, Figure 4. will appear on the screen. It tells the user what factors the DSS uses to evaluate the proposed page. It allows the user to evaluate their proposed page using:

1. all the rules for all five variables
2. selected rules for a single variable
3. selected rules for a combination of variables

This DSS can check each page for all five variables in tandem or it can check the page one variable at a time. If the second method of evaluation is chosen, the systems's recommendations will be displayed one factor at a time, in the order the factor's where chosen by the user. The evaluations are iterative, in that each subsequent evaluation incorporates the previous recommendations. The order the factors were chosen in this thesis are graphics, style, organization,

visual structure of the page. After the user selects the factor he/she would like the page evaluated for, Figures 5-8, the rules for each factor, will appear. These screens allow the user to select the rules they want the DSS to use when it evaluates a page.

Figure 9 is the user's proposed page design. Figures 10 - 14 display the system's recommendations as it goes through the iterative evaluation process.

The user has the option to save the changes, print the changes, to precede to the next evaluation,return to the rule selection screen or exit the program,after each evaluation.

The important feature of this DSS is its ability to provide recommendations the user should follow. **The system provides recommendations only; it does not arbitrarily change the user's text or design.**

In this chapter the design for the proposed DSS was displayed. The final chapter will be conclusions and recommendations for the entire thesis.

**General DSS Instructions**

General instructions for exiting the program and moving between the levels of the program are presented below. These instructions can be used at any level of the program.

To return to a previously selected screen/level

1. Push the ESC Key
2. If you are at this screen and hit the ESC key you will EXIT out of the program.

To Exit out of the program from any place in the program

1. Hit SHIFT F2

To use previously selected rules from your last session

1. Hit SHIFT F3
2. The rules you choose to use for a session are automatically saved when you exit the program.
3. When you push SHIFT F3 here, you go automatically to the recommendation screens.

To continue with the program hit any KEY.

**Figure 2. General DSS Instructions**

This DSS is designed to provide recommendations about a proposed page of the manual, after you complete that page.

The feedback will be presented in the following manner, two pages will be displayed side by side.

| | |
|---|---|
| The Left Hand Page - | Will be the user's proposed page design.<br><br>The heading on the TOP of this page will read **User's Proposed Page Design.** |
| The Right Hand Page- | Will be the critic's recommended page design.<br>The heading on the TOP of this Page will read **Critic's Proposed Page Design.** |

This DSS has four types of critics, that will be explained below.

The user can select the type of advice he or she would like to receive, by activating that critic.

To activate a critic:

1. Move the cursor to the desired critic

2. Press the ENTER key.

**Critics**

**Reactive**: a reactive critic will make comments about what the user has done.

**Active**: an active critic suggests what the user might do or proposes criteria the user should consider

**Positive**: a positive critic praises a superior design or complains about an inferior design.

**Negative**: a negative critic complains about unsatisfactory designs and does not praise useful or interesting designs.

**Figure 3. DSS Introductory Screen**

This DSS provides advice on five factors that affect the design of a manual.

The DSS can check each page for all five factors, but it can only check the page one factor at a time.

However when you select a factor you can select more than one. The DSS will check for each factor separately, in the order you selected the factors. There will be a separate page of recommendations produced for each factor. Each subsequent recommendation will incorporate the previous recommendations.

There will be a final recommendation that incorporates all the recommended changes.

**Graphics**: The layout, design and placement of graphs, charts,figures and illustrations in the text.

**Organization**: Arranging of the content in a logical manner so information is quickly and easily ascertained.

**Visual Structure of the Page**: The arrangement and layout of type, words, sentences and paragraphs in a text to enhance the appearance of the text on the page.

**Style**: The writer's selection and choice of words, sentences, sentence type and structures to make the text more readable and understandable.

**Grade Level**: is the grade level at which the document is written this will automatically appear as the last recommendation.

**Final All**: produces a version of the page that incorporates the recommendations from all the rules in all factors.

**Final Select**: produces a version of the page that incorporates the recommendations for only the factors and rules the user selects.

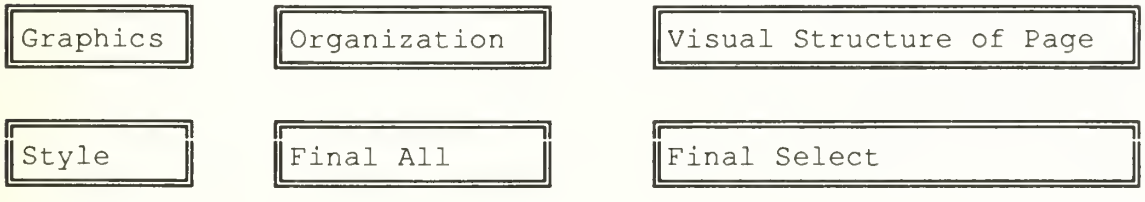


**Figure 4. DSS Factor Selection Screen Graphics Rules**

## Graphics Rules

The rules the DSS uses to evaluate the graphical quality of a proposed page are listed below. You can choose the rules you would like the DSS to use.

How to choose the rules:

1. Move the cursor to the YES or NO box and push the ENTER key.

| | | |
|---|---|---|
| a. Choose all the graphics rules | Yes | No |
| b. Whenever possible do not present information in prose. | Yes | No |
| c. Orient charts so they are read left to right. | Yes | No |
| d. Repeat tables whenever they will be used in the text. | Yes | No |
| e. Place columns within a table closer together rather than spacing them across the page. | Yes | No |
| f. Use the best type of graphical display for a specific purpose | Yes | No |
| | Yes | No |

**Figure 5. Graphics Rule Selection Screen Organization Rules**

## Organization Rules

The rules the DSS uses to evaluate the organization of a proposed page are listed below. You can choose the rules you would like the DSS to use.

How to choose the rules:

1. Move the cursor to the YES or NO box and push the ENTER key.

a. Choose all the organizational rules — Yes / No

b. Present only the information the user needs. — Yes / No

c. Write headings as questions or verb phrases — Yes / No

d. Include a table of contents — Yes / No

e. Set up signposts — Yes / No

**Figure 6. Organization Rule Selection Screen**
**Visual Structure of a Page Rules**

**Visual Structure of a Page Rules**

The rules the DSS uses to evaluate the visual structure of a proposed page are listed below. You can choose the rules you would like the DSS to use.

How to choose the rules:

1. Move the cursor to the YES or NO box and push the ENTER key.

a. Choose all the visual structure rules — Yes / No

b. Use boldface type to emphasize words or short portions of the text — Yes / No

c. Use white space to enhance the appearance of the text. — Yes / No

**Figure 7. Visual Structure of a Page Rule Selection Screen Style Rules**

**Style Rules**

The rules the DSS uses to evaluate the style a proposed page was written from are listed below. You can choose the rules you would like the DSS to use.

How to choose the rules:

1. Move the cursor to the YES or NO box and push the ENTER key.

| | | |
|---|---|---|
| a. Choose all the style rules | Yes | No |
| b. Use personal pronouns | Yes | No |
| c. Use strong action verbs | Yes | No |
| d. Use ordinary words | Yes | No |
| e. Present information in concrete terms. | Yes | No |
| f. Write sentences that do not overtax short term memory | Yes | No |
| g. Avoid the use of complex condtional sentences. | Yes | No |

**Figure 8. Style Rule Selection Screen User's Proposed Page Design**

**User's Proposed Page Design**

To use a checkbook, you need to do several things: The money deposited into the account should be recorded in the ledger,The payee should be recorded in the ledger,The number of the check should be recorded in the ledger, the date of the check should be recorded in the ledger, The amount of the check should be subtracted from the previous balance, the new balance should be recorded in the ledger.

**Figure 9. Proposed Page Design That The DSS Will Evaluate Critic's Proposed Page Design (Graphics)**

**Critic's Proposed Page Design (Graphics)**

To use a checkbook, you need to do several things:

1. The money deposited into the account should be recorded in the ledger.
2. The payee should be recorded in the ledger.
3. The number of the check should be recorded in the ledger.
4. The date of the check should be recorded in the ledger.
5. The amount of the check should be subtracted from previous balance.
6. The new balance should be recorded in the ledger.

---

Recommendations:

1. You should consider presenting the information in a list vice prose.
2. There are no illustrations, you should consider adding them.
3. The reading level is ninth grade
4. To return to the rule selection screen hit shift F1

Save changes ? Yes No

Print changes ? Yes No

Check next factor ? Yes No

Exit Program ? Yes No

**Figure 10. Graphics Recommendations**

**Critic's Proposed Page Design (Style)**

To use a checkbook, you need to do several things:

1 Record the amount of money deposited into the checkbook in the **ledger**.

2. Record the **payee** in the **ledger**.

3. Record the check **number** in the **ledger**.

4. Record the date the check was written in the **ledger**.

5. Subtract the amount of the check, from the previous balance.

6. Record the new balance in the **ledger**. previous balance.

---

Recommendations:

1. You should consider making the sentences active vice passive.

2. You should consider replacing the highlighted words with simpler words.

3. Words that are both highlighted and underlined are misspelled.

4. The reading level is ninth grade

5. To return to the rule selection screen hit shift F1

Save changes ? [Yes] [No]

Print changes ? [Yes] [No]

Check next factor ? [Yes] [No]

Exit Program ? [Yes] [No]

**Figure 11. Style Recommendations**

**Critic's Proposed Page Design (Organization)**

How do I use my checkbook ?

1 Record the amount of money deposited into the checkbook in the **ledger**.

2. Record the **payee** in the **ledger**.

3. Record the check number in the **ledger**.

4. Record the date the check was written in the **ledger**.

5. Subtract the amount of the check, from the previous balance.

6. Record the new balance in the **ledger**. previous balance.

---

Recommendations:

1. You should consider writing this sentence as heading. You should consider making the heading a questions or verb phrase.

2. The reading level is ninth grade

3. To return to the rule selection screen hit shift F1

Save changes ? Yes No

Print changes ? Yes No

Check next factor ? Yes No

Exit Program ? Yes No

**Figure 12. Organization Recommendations**

**Critic's Proposed Page Design (Visual Structure of the Page)**

How do I use my checkbook ?

1 Record the amount of money deposited into the checkbook in the **ledger**.

2. Record the **payee** in the **ledger**.

3. Record the check number in the **ledger**.

4. Record the date the check was written in the **ledger**.

5. Subtract the amount of the check, from the previous balance.

6. Record the new balance in the **ledger**.
previous balance.

---

Recommendations:

1. The page layout looks find, there are no recommended changes.

2. The reading level is ninth grade.

3. To return to the rule selection screen hit shift F1

Save changes ? [Yes] [No]

Print changes ? [Yes] [No]

Check next factor ? [Yes] [No]

Exit Program ? [Yes] [No]

**Figure 13. Visual Structure of a Page Recommendations**

**Critic's Proposed Page Design (Final All Recommendations)**

How do I use my checkbook ?

1 Record the amount of money deposited into the checkbook in the **ledger**.

2. Record the **payee** in the **ledger**.

3. Record the check number in the **ledger**.

4. Record the date the check was written in the **ledger**.

5. Subtract the amount of the check, from the previous balance.

6. Record the new balance in the **ledger**.
previous balance.

---

Recommendations:

1. This is the final recommendation for the page, it incorporates the recommendations for all the rules in all five factors.

2. The reading level is ninth grade.

Save changes ? Yes No

Print changes ? Yes No

Check next page ? Yes No

Exit Program ? Yes No

**Figure 14. Final Recommendation That Incorporates All The Changes**

# V. CONCLUSIONS AND RECOMMENDATIONS

## A. CONCLUSIONS

The DSS proposed in this thesis had been designed to evaluate instruction manuals for five factors:

1. Graphics
2. Organization
3. Visual Structure of a Page
4. Style
5. Reading Grade level

Current literature in the document design and Plain English field has been examined, to develop the rules for this system.

The system allows the user to select:

1. The type of advice he/she would like to receive
2. The factors and rules they would like the DSS to use when it evaluates an instruction manual

Finally, the system produces a series of recommendations based on the evaluation factors and rules the user selected.

## B. RECOMMENDATIONS

The purpose of this thesis was to propose a design for a DSS, which will help document designers develop instruction

manuals that are readable and useable. Since the actual system was not built, it is recommended that:

1. A follow on thesis be done to build the system.
2. Another thesis be done, after the system is built to test and revise the system.
3. After the system is built and tested, that the system be distributed throughout DoD.

## APPENDIX A

## READABILITY FORMULAS

**Flesch-Scale** RE = 206.835 - (.865 * wl)-(1.015 * sl)

**Dale-Chall** C50 = 3.6365 + (.1579 * ndw) + (.0496 * sl)

**Gunning Fog** GR = .4 * (np + sl)

**RE** = reading ease

**wl** = word length (number of syllables per 100 words)

**sl** = average sentence length in words

**ndw** = percent of words not on dale list of 3000 words

**gr** = grade [Ref. 1:p. 43] [Ref 77] [Ref. 78:pp. 11-20] [Ref. 79]

APPENDIX B

# DMDC ASVAB VE SCORE FOR DoD E-1'S -E-5'S

BY SERVICE AND RANK

PAYGRADES E1 - E5

ARMY

| YE | PG 1 | 2 | 3 | 4 | 5 | TOTAL |
|---|---|---|---|---|---|---|
| 0 | . | . | 1 | . | . | 1 |
| 20 | . | 3 | 7 | 3 | 2 | 15 |
| 21 | 1 | . | 10 | 9 | 2 | 22 |
| 22 | . | . | . | . | 1 | 1 |
| 23 | . | . | . | . | 2 | 2 |
| 24 | . | . | . | . | 2 | 2 |
| 26 | . | . | . | 2 | 2 | 4 |
| 27 | . | . | . | 2 | 16 | 18 |
| 28 | . | 1 | . | 4 | 14 | 19 |
| 29 | 2 | 1 | 6 | 6 | 27 | 42 |
| 30 | . | . | 7 | 13 | 59 | 79 |
| 31 | . | 2 | 2 | 32 | 79 | 115 |
| 32 | 4 | 1 | 12 | 40 | 136 | 193 |
| 33 | 8 | 5 | 27 | 84 | 185 | 309 |
| 34 | 7 | 7 | 58 | 172 | 299 | 543 |
| 35 | 11 | 17 | 50 | 176 | 337 | 591 |
| 36 | 17 | 20 | 112 | 298 | 546 | 993 |
| 37 | 35 | 58 | 281 | 702 | 1385 | 2461 |
| 38 | 60 | 90 | 360 | 819 | 1022 | 2351 |
| 39 | 95 | 178 | 743 | 1513 | 1254 | 3783 |
| 40 | 120 | 208 | 716 | 1548 | 1346 | 3938 |
| 41 | 224 | 321 | 1071 | 1990 | 1650 | 5256 |
| 42 | 291 | 410 | 1318 | 2455 | 1812 | 6286 |
| 43 | 417 | 532 | 1599 | 2943 | 2071 | 7562 |
| 44 | 782 | 1075 | 3076 | 5986 | 2757 | 13676 |
| 45 | 907 | 1073 | 2652 | 4662 | 2585 | 11879 |
| 46 | 977 | 1156 | 3033 | 5560 | 2843 | 13569 |
| 47 | 1239 | 1400 | 3361 | 5794 | 2933 | 14727 |
| 48 | 1730 | 2060 | 5336 | 10084 | 3856 | 23066 |
| 49 | 1759 | 1993 | 4423 | 6952 | 3242 | 18369 |
| 50 | 2526 | 2984 | 5752 | 8291 | 3804 | 23357 |

(CONTINUED)

BY SERVICE AND RANK

PAYGRADES E1 - E5

ARMY

| | PG | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | TOTAL |
| VE | | | | | | |
| 51 | 2068 | 2337 | 4810 | 7639 | 3625 | 20479 |
| 52 | 2064 | 2469 | 4966 | 7908 | 3693 | 21100 |
| 53 | 2462 | 3047 | 7024 | 13056 | 5216 | 30805 |
| 54 | 2692 | 3240 | 6627 | 10912 | 6366 | 29837 |
| 55 | 2321 | 2892 | 5652 | 8109 | 3916 | 22890 |
| 56 | 2796 | 3225 | 6155 | 9317 | 4433 | 25926 |
| 57 | 2945 | 3677 | 7686 | 13183 | 6120 | 33611 |
| 58 | 2101 | 2638 | 5066 | 7686 | 4364 | 21855 |
| 59 | 2137 | 2615 | 5465 | 8233 | 4863 | 23313 |
| 60 | 1795 | 2116 | 4605 | 6794 | 4461 | 19771 |
| 61 | 970 | 1256 | 3270 | 5963 | 4247 | 15706 |
| 62 | 232 | 329 | 1282 | 3974 | 3038 | 8855 |
| EDUC | | | | | | |
| NON HS | 1355 | 3652 | 7284 | 11330 | 7727 | 31348 |
| HS GRAD | 34440 | 39784 | 89337 | 151584 | 80884 | 396029 |
| TOTAL | 35795 | 43436 | 96621 | 162914 | 88611 | 427377 |

BY SERVICE AND RANK

PAYGRADES E1 - E5

NAVY

| YE | PG 1 | 2 | 3 | 4 | 5 | TOTAL |
|---|---|---|---|---|---|---|
| 20 | 3 | 2 | 1 | 1 | 1 | 8 |
| 21 | . | 1 | 11 | 2 | 1 | 15 |
| 23 | . | . | . | 1 | 2 | 3 |
| 25 | . | . | . | 1 | . | 1 |
| 26 | . | . | . | 1 | 3 | 4 |
| 27 | . | . | . | 1 | 4 | 5 |
| 28 | . | 1 | 1 | . | 6 | 8 |
| 29 | 1 | . | 4 | 4 | 9 | 18 |
| 30 | 2 | 2 | 2 | 9 | 15 | 30 |
| 31 | 2 | 3 | 11 | 14 | 32 | 62 |
| 32 | 4 | 7 | 11 | 19 | 38 | 79 |
| 33 | 7 | 14 | 22 | 45 | 70 | 158 |
| 34 | 13 | 26 | 41 | 104 | 89 | 273 |
| 35 | 21 | 35 | 48 | 109 | 149 | 362 |
| 36 | 29 | 88 | 112 | 166 | 153 | 548 |
| 37 | 81 | 186 | 269 | 393 | 528 | 1457 |
| 38 | 121 | 209 | 357 | 453 | 424 | 1564 |
| 39 | 196 | 424 | 742 | 847 | 578 | 2787 |
| 40 | 242 | 460 | 698 | 940 | 695 | 3035 |
| 41 | 417 | 710 | 949 | 1073 | 832 | 3981 |
| 42 | 519 | 843 | 1169 | 1333 | 974 | 4838 |
| 43 | 757 | 1062 | 1419 | 162 | 1152 | 6011 |
| 44 | 1246 | 1910 | 2908 | 3084 | 1532 | 10680 |
| 45 | 1338 | 1788 | 2098 | 2306 | 1549 | 9079 |
| 46 | 1491 | 1915 | 2470 | 2700 | 1788 | 10364 |
| 47 | 1539 | 2048 | 2631 | 2744 | 1930 | 10892 |
| 48 | 2108 | 3056 | 4355 | 4740 | 2551 | 16810 |
| 49 | 2124 | 2530 | 3066 | 3340 | 2271 | 13331 |
| 50 | 2760 | 3300 | 3689 | 4063 | 2636 | 16448 |
| 51 | 2088 | 2619 | 3283 | 3904 | 2748 | 14642 |
| 52 | 2161 | 2773 | 3262 | 4054 | 2920 | 15170 |

(CONTINUED)

PAYGRADES E1 - E5

NAVY

| | PG | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | TOTAL |
| VE | | | | | | |
| 53 | 2318 | 3325 | 5025 | 6796 | 4269 | 21733 |
| 54 | 2571 | 3349 | 4320 | 6611 | 5886 | 22737 |
| 55 | 2142 | 2855 | 3421 | 5021 | 3969 | 17408 |
| 56 | 2412 | 3166 | 3753 | 6072 | 4420 | 19823 |
| 57 | 2423 | 3698 | 4769 | 9163 | 6197 | 26250 |
| 58 | 1546 | 2326 | 3069 | 6049 | 4669 | 17659 |
| 59 | 1336 | 2188 | 3337 | 6669 | 5362 | 18892 |
| 60 | 948 | 1746 | 2808 | 5961 | 5145 | 16608 |
| 61 | 425 | 886 | 1935 | 5005 | 4823 | 13074 |
| 62 | 107 | 263 | 782 | 2991 | 3427 | 7570 |
| EDUC | | | | | | |
| NON HS | 3675 | 5291 | 4779 | 6334 | 5758 | 25837 |
| HS GRAD | 31823 | 44523 | 62069 | 92076 | 68089 | 298580 |
| TOTAL | 35498 | 49814 | 66848 | 98410 | 73847 | 324417 |

BY SERVICE AND RANK

PAYGRADES E1 - E5

MC

| | PG | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | TOTAL |
| VE | | | | | | |
| 20 | . | 2 | 1 | 1 | 1 | 5 |
| 21 | . | . | 4 | . | . | 4 |
| 25 | . | . | . | . | 1 | 1 |
| 28 | 1 | . | . | . | 1 | 2 |
| 29 | . | . | . | . | 1 | 1 |
| 30 | . | . | . | 3 | 3 | 6 |
| 31 | . | 2 | 3 | 1 | 3 | 9 |
| 32 | . | . | . | 5 | 6 | 11 |
| 33 | 3 | . | 1 | 5 | 7 | 16 |
| 34 | 1 | 3 | 8 | 9 | 10 | 31 |
| 35 | 2 | 5 | 7 | 15 | 16 | 45 |
| 36 | 3 | 10 | 25 | 17 | 39 | 94 |
| 37 | 3 | 18 | 49 | 65 | 138 | 273 |
| 38 | 18 | 30 | 86 | 65 | 105 | 304 |
| 39 | 25 | 50 | 214 | 149 | 136 | 574 |
| 40 | 42 | 75 | 250 | 176 | 193 | 736 |
| 41 | 49 | 131 | 318 | 254 | 258 | 1010 |
| 42 | 85 | 132 | 470 | 303 | 324 | 1314 |
| 43 | 138 | 224 | 656 | 441 | 375 | 1834 |
| 44 | 237 | 444 | 1466 | 770 | 433 | 3350 |
| 45 | 300 | 558 | 1281 | 668 | 511 | 3318 |
| 46 | 361 | 587 | 1667 | 848 | 586 | 4049 |
| 47 | 429 | 706 | 1774 | 915 | 658 | 4482 |
| 48 | 546 | 1077 | 3459 | 1651 | 752 | 7485 |
| 49 | 602 | 1031 | 2431 | 1202 | 738 | 6004 |
| 50 | 850 | 1451 | 3236 | 1485 | 807 | 7829 |
| 51 | 654 | 1204 | 2977 | 1427 | 876 | 7138 |
| 52 | 666 | 1272 | 3148 | 1595 | 865 | 7546 |
| 53 | 816 | 1531 | 4791 | 2733 | 1150 | 11021 |
| 54 | 846 | 1521 | 4191 | 2460 | 1725 | 10743 |
| 55 | 728 | 1285 | 3235 | 1850 | 1050 | 8148 |

(CONTINUED)

BY SERVICE AND RANK

PAYGRADES E1 - E5

MC

| | PG | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | TOTAL |
| VE | | | | | | |
| 56 | 776 | 1510 | 3625 | 2108 | 1110 | 9129 |
| 57 | 761 | 1600 | 4785 | 3149 | 1346 | 11641 |
| 58 | 520 | 1098 | 2792 | 1893 | 1136 | 7439 |
| 59 | 482 | 1045 | 2870 | 1950 | 1123 | 7470 |
| 60 | 328 | 887 | 2272 | 1569 | 1033 | 6089 |
| 61 | 174 | 427 | 1599 | 1302 | 892 | 4394 |
| 62 | 42 | 122 | 764 | 784 | 509 | 2221 |
| EDUC | | | | | | |
| NON HS | 731 | 1474 | 2803 | 1792 | 2079 | 8879 |
| HS GRAD | 9757 | 18564 | 51652 | 30076 | 16838 | 126887 |
| TOTAL | 10488 | 20038 | 54455 | 31868 | 18917 | 135766 |

BY SERVICE AND RANK

PAYGRADES E1 - E5

AF

| | PG | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | TOTAL |
| YE | | | | | | |
| 21 | . | 1 | 1 | . | . | 2 |
| 27 | . | . | . | . | 1 | 1 |
| 28 | . | . | . | 2 | 1 | 3 |
| 29 | . | . | . | 1 | 1 | 2 |
| 31 | . | 1 | . | 4 | . | 5 |
| 32 | . | . | . | 2 | 6 | 8 |
| 33 | . | . | . | 5 | 6 | 11 |
| 34 | . | . | . | 7 | 12 | 19 |
| 35 | . | . | 3 | 13 | 20 | 36 |
| 36 | . | 1 | 2 | 26 | 38 | 67 |
| 37 | . | 2 | 5 | 101 | 148 | 256 |
| 38 | 2 | 4 | 10 | 106 | 109 | 231 |
| 39 | 8 | 5 | 32 | 171 | 148 | 364 |
| 40 | 4 | 16 | 25 | 273 | 250 | 568 |
| 41 | 12 | 23 | 54 | 387 | 297 | 773 |
| 42 | 24 | 40 | 107 | 634 | 474 | 1279 |
| 43 | 43 | 67 | 155 | 971 | 544 | 1780 |
| 44 | 68 | 173 | 355 | 1674 | 692 | 2962 |
| 45 | 118 | 239 | 446 | 1760 | 897 | 3460 |
| 46 | 187 | 334 | 752 | 2461 | 1085 | 4819 |
| 47 | 236 | 480 | 945 | 2982 | 1320 | 5963 |
| 48 | 380 | 786 | 1805 | 5206 | 1659 | 9836 |
| 49 | 493 | 906 | 1749 | 4508 | 1801 | 9457 |
| 50 | 736 | 1384 | 2471 | 5469 | 1943 | 12003 |
| 51 | 753 | 1307 | 2696 | 5532 | 2192 | 12480 |
| 52 | 829 | 1560 | 2970 | 5840 | 2432 | 13631 |
| 53 | 950 | 2062 | 4845 | 9238 | 2687 | 19782 |
| 54 | 1266 | 2438 | 4810 | 10243 | 5523 | 24280 |
| 55 | 1050 | 1865 | 3850 | 6538 | 3007 | 16310 |
| 56 | 1138 | 2130 | 4521 | 7327 | 3139 | 18255 |
| 57 | 1273 | 2577 | 6247 | 10331 | 3578 | 24006 |

(CONTINUED)

BY SERVICE AND RANK

PAYGRADES E1 - E5

AF

| | PG | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | TOTAL |
| VE | | | | | | |
| 58 | 880 | 1645 | 4050 | 6443 | 3362 | 16380 |
| 59 | 830 | 1618 | 4450 | 6902 | 3754 | 17554 |
| 60 | 655 | 1175 | 3832 | 5788 | 3477 | 14927 |
| 61 | 338 | 664 | 2817 | 4882 | 3067 | 11768 |
| 62 | 60 | 208 | 1326 | 3139 | 1870 | 6603 |
| EDUC | | | | | | |
| NON HS | 89 | 165 | 225 | 341 | 296 | 1116 |
| HS GRAD | 12244 | 23546 | 55106 | 108625 | 49244 | 248765 |
| TOTAL | 12333 | 23711 | 55331 | 108966 | 49540 | 249881 |

BY SERVICE AND RANK

PAYGRADES E1 - E5

TOTAL

| | PG | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | TOTAL |
| VE | | | | | | |
| 0 | . | . | 1 | . | . | 1 |
| 20 | 3 | 7 | 9 | 5 | 4 | 28 |
| 21 | 1 | 2 | 26 | 11 | 3 | 43 |
| 22 | . | . | . | . | 1 | 1 |
| 23 | . | . | . | 1 | 4 | 5 |
| 24 | . | . | . | . | 2 | 2 |
| 25 | . | . | . | 1 | 1 | 2 |
| 26 | . | . | . | 3 | 5 | 8 |
| 27 | . | . | . | 3 | 21 | 24 |
| 28 | 1 | 2 | 1 | 6 | 22 | 32 |
| 29 | 3 | 1 | 10 | 11 | 38 | 63 |
| 30 | 2 | 2 | 9 | 25 | 77 | 115 |
| 31 | 2 | 8 | 16 | 51 | 114 | 191 |
| 32 | 8 | 8 | 23 | 66 | 186 | 291 |
| 33 | 18 | 19 | 50 | 139 | 268 | 494 |
| 34 | 21 | 36 | 107 | 292 | 410 | 866 |
| 35 | 34 | 57 | 108 | 313 | 522 | 1034 |
| 36 | 49 | 119 | 251 | 507 | 776 | 1702 |
| 37 | 119 | 264 | 604 | 1261 | 2199 | 4447 |
| 38 | 201 | 333 | 813 | 1443 | 1660 | 4450 |
| 39 | 324 | 657 | 1731 | 2680 | 2116 | 7508 |
| 40 | 408 | 759 | 1689 | 29[illegible] | 2484 | 8277 |
| 41 | 702 | 1185 | 2392 | 3704 | 3037 | 11020 |
| 42 | 919 | 1425 | 3064 | 4725 | 3584 | 13717 |
| 43 | 1355 | 1885 | 3829 | 5976 | 4142 | 17187 |
| 44 | 2333 | 3602 | 7805 | 11514 | 5414 | 30668 |
| 45 | 2663 | 3658 | 6477 | 9396 | 5542 | 27736 |
| 46 | 3016 | 3992 | 7922 | 11569 | 6302 | 32801 |
| 47 | 3443 | 4634 | 8711 | 12435 | 6841 | 36064 |
| 48 | 4764 | 6979 | 14955 | 21681 | 8818 | 57197 |
| 49 | 4978 | 6460 | 11669 | 16002 | 8052 | 47161 |

(CONTINUED)

PAYGRADES E1 - E5

TOTAL

| | PG | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | TOTAL |
| VE | | | | | | |
| 50 | 6872 | 9119 | 15148 | 19308 | 9190 | 59637 |
| 51 | 5563 | 7467 | 13766 | 18502 | 9441 | 54739 |
| 52 | 5720 | 8074 | 14346 | 19397 | 9910 | 57447 |
| 53 | 6546 | 9965 | 21685 | 31823 | 13322 | 83341 |
| 54 | 7375 | 10548 | 19948 | 30226 | 19500 | 87597 |
| 55 | 6241 | 8897 | 16158 | 21518 | 11942 | 64756 |
| 56 | 7122 | 10031 | 18054 | 24824 | 13102 | 73133 |
| 57 | 7402 | 11552 | 23487 | 35826 | 17241 | 95508 |
| 58 | 5047 | 7707 | 14977 | 22071 | 13531 | 63333 |
| 59 | 4785 | 7466 | 16122 | 23754 | 15102 | 67229 |
| 60 | 3726 | 5924 | 13517 | 20112 | 14116 | 57395 |
| 61 | 1907 | 3233 | 9621 | 17152 | 13029 | 44942 |
| 62 | 441 | 922 | 4154 | 10888 | 8844 | 25249 |
| EDUC | | | | | | |
| NON HS | 5850 | 10582 | 15091 | 19797 | 15860 | 67180 |
| HS GRAD | 88264 | 126417 | 258164 | 382361 | 215055 | 1070261 |
| TOTAL | 94114 | 136999 | 273255 | 402158 | 230915 | 1137441 |

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